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WINTER OPERATIONS AT WMATA

Report Of The Peer Review Committee

Report of the Peer Review Committee for Winter Operations at the Washington Metropolitan Area Transit Authority

July, 1987

PREPARED BY THE
AMERICAN PUBLIC TRANSIT ASSOCIATION

FORWARD

WMATA Winter Operations Peer Review Service

The purpose of the Peer Review Service organized by the American Public Transit Association is to provide expert transit industry review of transit problems.

The benefits to the transit industry and each participating transit system are an increased level of information exchange and independent review of system practices by persons specializing in transit operations.

The Peer Review Service functions as an activity of the American Public Transit Association, the international organization representing the urban transit industry. APTA members serve the public interest by providing safe, efficient, reliable, and economical transit service, and by improving that service to meet national energy, environmental, and financial concerns. Ninety-five percent of those using urban public transit in the U.S. are carried by APTA members.

APTA members include nearly 400 motor bus and rapid transit systems, and the organizations responsible for planning, designing, constructing, financing and operating transit systems. In addition, APTA members include business organizations which supply products and services to the urban transit industry, academic institutions, and public interest groups.

As a background to this report, snow storms on January 22 and 25/26, 1987 caused severe disruption to bus and rail service of the Washington Metropolitan Area Transit Authority (WMATA).

Utilizing the APTA Peer Review Service, WMATA General Manager Carmen E. Turner requested APTA to establish a Peer Review Committee to review the service disruptions.

The Committee, which was charged with investigating the cause of the service disruptions and reporting its findings and recommendations to WMATA, included Paul Lennon, Chief Transportation Officer of the Massachusetts Bay Transportation Authority; Ian Kingston, Manager-Plant of the Toronto Transit Commission; Erich Vogel, Chief Mechanical Officer of the Southeastern Pennsylvania Transportation Authority; Kevin O'Connell, General Superintendent, Rail Transit Command Center of the New York City Transit Authority; Thomas A. Tutko, General Superintendent-Road Operations of the Port Authority of Allegheny County and C. William Baxa, Manager-Public Affairs of the Chicago Transit Authority. Mr. Lennon was named Chairman of the Committee and Mr. Kingston, Vice Chairman. Staff support to the Committee was provided by Frank J. Cihak, Executive Director-Technical Services, APTA.

The Committee began its investigation the week after the storms, visiting the yards and the Operations Control Centers, and reviewing pertinent records, equipment, and facilities. Committee members interviewed key WMATA personnel. The Committee also was provided with the WMATA reports of the severe weather emergency as well as reference materials requested by the Committee.

TABLE OF CONTENTS

I. EXECUTIVE SUMMARY

WHAT HAPPENED

On Thursday, January 22, beginning in the early morning, a total of 11 inches of snow fell in the Washington, D.C. area. Temperatures fell for the next four days and on Sunday, January 25 and Monday, January 26 an additional nine inches of snow fell. The light powdery nature of the snow combined with high winds to cause drifting. The result was disrupted Washington Metropolitan Area Transit Authority Metrobus* and Metrorail** service. Metrorail operations were disrupted on surface sections and eventually surface rail operations were discontinued. The cold weather between the snowstorms delayed recovery efforts. Many rail cars were not available for service due to needed repairs and the difficulties in moving cars in the rail yards.

Metrobus and Metrorail operations were gradually restored and full operation was reached on January 29.

The Peer Review Committee reviewed the operations of the Washington Metropolitan Area Transit Authority (hereafter WMATA) during the period January 22-29 and prepared findings and recommendations to mitigate the effects of severe weather on WMATA operations.

WHY WAS WMATA SERVICE DISRUPTED?

Many factors combined to disrupt WMATA bus and rail services. The WMATA Severe Weather Plan was not sufficiently coordinated to overcome the disruptions caused by two snowstorms. The design of the third rail coverboard traps snow and the consequent arcing of the current collector shoes results in ice formation on the third rail. This process damages car equipment and eventually causes trains to stall. This happened many times during the snowstorm. The recovery of stalled trains and removal of passengers was delayed unreasonably.

In the process of maintaining rail service and arranging for the removal of passengers from stalled trains, some snow plowing equipment was not utilized fully. The WMATA ice clearing equipment was not tested and evaluated fully nor was there a coordinated plan for its deployment.

Passenger announcements were deficient in accuracy during the initial days of the storm. A great deal of public trust therefore was lost. The cars experienced frequent malfunctions due to the cold and snow. Few cars were available for service on days when maximum length trains were needed.

THE COMMITTEE'S MAIN RECOMMENDATIONS

The following represent the most important recommendations that the Committee urges for the consideration of WMATA management. The responsibility for action rests with WMATA management which may develop alternate solutions that produce equal or better results than those recommended by the Committee.

1. Prepare an integrated severe weather plan providing for centralized decision making authority over all line departments that will include a clearly defined chain of command. An external goal would be to have a regional severe weather plan that would use a single weather forecast as the basis for decisions.
2. Evaluate modifications to railcar subsystems to reduce effects of cold and snow.
3. Make maximum effective use of snow plowing equipment.
4. Test and evaluate ice clearing vehicles to improve usage, effectiveness and compatibility with revenue trains.
5. Modify the third rail coverboard to reduce or eliminate the tendency to trap snow, and consider installation of third rail heaters at critical locations.
6. Improve the accuracy and timeliness of media and passenger announcements.

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* Bus operations of WMATA are known as Metrobus
** Rail operations of WMATA are known as Metrorail

II. INVESTIGATION

THE FIRST STORM (January 22,1987)

The radio and television evening weather forecasts in the Washington, DC Metropolitan Area on Wednesday, January 21, 1987 called for four to six inches of snow on the next day. About 5:00 a.m. on Thursday, January 22, snow began falling rapidly and significant accumulation began. Two inches fell by 7:00 a.m. Regional commuter movements quickly became difficult. WMATA bus operations (hereafter Metrobus) and rail operations (hereafter Metrorail) operated under increasingly difficult conditions during the morning rush hour.

About 10:00 a.m. the Federal Office of Personnel Management (OPM) decided to release federal employees from Virginia at 10:30 a.m., Maryland employees at 11:30 a.m., and District of Columbia employees at 12:30 p.m. The District of Columbia government decided to release their employees at 12:30 p.m. as did many employers in the area. The snow fall amounted to six inches at 10:00 a.m.

WMATA retained all available personnel from the morning rush hour and began implementing a modified rush hour service for Metrobus and Metrorail.

Metrorail service carried heavy passenger loads to outlying stations where Metrobus service frequently was unavailable leaving passengers to find any available means of transportation.

The heavy snowfall and blowing snow conditions dragged down Metrorail service late in the afternoon. Metrorail experienced stalled trains on the Red and Orange lines. After about 4:00 p.m. Metrorail service was restricted to the underground portion of the system. Buses were used to provide service along surface rail routes. Metrobus movements in the late afternoon and evening frequently were obstructed by closed roads and stalled automobiles.

Public announcements were frequent throughout Thursday but lacked factual content of actual conditions and often were misleading.

A total of eleven inches of snow fell on January 22nd.

RECOVERY (January 23-24)

Friday was cold, clear and no snow fell, however winds were high, between 15 and 30 mph. This caused constant drifting of snow. Metrorail operations were disrupted and sporadic service was provided with reduced train lengths. Metrobuses were confined to main routes and their service was slow due to stalled cars and the limited lanes available. The number of rail cars available for service in the PM period dropped by 28%.

Saturday, January 24, was cold and clear. Limited Metrorail service continued all day.

THE SECOND STORM (January 25-26)

Sunday, January 25, began with early snow. This snowfall became heavy in the late afternoon. Again limited Metrorail service was provided with reduced length trains. Service frequently was disrupted and heavy passenger loads were experienced. Snow continued throughout the night. Five inches of snow fell on Sunday.

Snow continued on Monday, January 26, and ended in mid-afternoon. Four additional inches of snow fell. The Federal Government offices were closed along with many other employers. Passenger loads were light to moderate. Trains were slow and infrequent with many delays. Metrobuses were used to bridge rail service gaps. As usual, buses were subject to road delays due to snow and stalled cars. A total of nine inches of snow fell on Sunday and Monday. The total accumulation from January 22-26 was twenty inches.

RECOVERY (January 27-28)

Tuesday, January 27, was very cold (9 degrees F) and clear. Winds were moderate. All Metrorail lines were open with heavy passenger loads. The Federal Government offices and most local employers were open. Metrorail trains were crowded due to short train lengths caused by limited rail car availability. Metrobuses were used to supplement rail service at various stations.

Wednesday, January 28, saw Metrorail service returned to all lines but trains again were restricted in length due to car availability. Metrobus service was restored to all but a few routes that had impassable streets and hills.

III. ANALYSIS

A. WMATA SEVERE WEATHER PLANS

The WMATA Management Memorandum No. 127, revision 1 (MM#1) dated January 30, 1985 provides for overall direction of authority activities and personnel during severe weather. It establishes levels of alert and an Emergency Operations Center (hereafter EOC) and a Support Operations Center (hereafter SOC). The memorandum also calls for and depends heavily on detailed supporting plans for activities of the various authority departments. These supporting plans are oriented to the goals and objectives of the individual departments.

The individual department plans are very comprehensive and detailed. They direct department responses to the WMATA alert levels such as personnel assignments, the loading and preparation of snow clearing equipment, public and media announcements, the operation of trains to keep trackways and third rails clear and the storage of trains in tunnels.

If there is an underlying theme throughout WMATA's snow plans as provided, it is that rail service must be maintained. The two storms that occurred in January, however, proved that segments of rail lines can be shut down despite the best efforts of dedicated personnel. At that point in time substitute bus service, as provided in an emergency back up plan, should be implemented. Such substitute bus service should run parallel where possible to the tracks and stations, so as to provide passengers a means of transport to a place of safety and/or further transport connections. It should be realized that such substitute parallel bus service would be temporary, at best, until the storm had subsided. There are two reasons for this; the *first* is that buses and the streets on which they run are even more susceptible than trains to weather conditions. The maneuverability that buses might normally enjoy over trains, is significantly compromised because of severe weather conditions. The *second* reason is that of capacity, in that to effectively carry a six-car train with capacity load of passengers would require a substantial number of buses.

Although it is evident that excellent communications exist between the various private and state government agencies in the Maryland, Virginia and District of Columbia area, these contacts did fail and will fail again unless lessons learned are captured and documented by each agency and put into a carefully coordinated Regional Snow Plan.

Each element of the regional snow plan will reflect an individual agency's responsibility for addressing a storm that is imminent and also would define the means and mechanism for contacting other agencies as well as communicating to its own workers what the agency expects of them.

The panel feels that the storm-related communication and coordination challenges that confronted the various public, private and government agencies within the District of Columbia, Virginia and Maryland, as well as for WMATA, are not necessarily unique to this particular storm or this geographic area. Throughout the snow belt region of North America, all the major cities and their respective transit systems continually face such communication and coordination problems. It is too quickly assumed however, by non-service agencies who actively are not involved in the movement of workers or the actual containment of the effects the storm (i.e., such as fire, and police agencies, hospitals, departments of public works, and transit systems), that they have very little role to play in the preparation for such storms. This is not the case, for such non-service agencies, especially those agencies that have large numbers of employees, can make a significant contribution by giving directions to their employees to stay home or come to work at predetermined alternate times and/or by methods of travel. Such announcements and determinations would be made after close coordination with other agencies and after obtaining a consensus with these agencies with regards to the accepted weather forecast.

To preclude the perception in the future of less-than-perfect communications among govern-

ment and state agencies every effort should be made by these agencies to think and function as one entity, especially in the face of a forthcoming storm of major proportions. The obtaining of such consensus however is not without risk, in that, if the storm does not materialize as predicted and workers are told to stay away then production is not met and tasks not performed, thereby impacting the local economy. This, however, should be balanced against what did occur in the Washington area between January 22-27 and which could occur again if every agency is left to its own weather predicting and decision-making devices. A regional severe weather plan should use a single weather forecast as a basis for decisions.

In accordance with WMATA's severe weather plan, the manning of the EOC should include all essential backup personnel defined therein to ensure the continuity of decision making and action taking throughout the storm emergency. The plan should include but not be limited to the actual names and classifications of the personnel who report to the EOC, the actual times for these individuals to report, as well as the projected times that they would be expected to remain. The duties and functions to be performed by these individuals also should be clearly defined within the plan. This would ensure that, for example, in the event of an actual train or bus-line shut down during the storm, the mechanism for terminating the service as well as evacuating those trains or buses that could become stranded during the storm, would be set into motion correctly, promptly and effectively. Such decision-making would be an ongoing 24-hour process and also would be monitored closely by the Public Affairs person based at EOC. It is important that WMATA's Public Affairs personnel provide 24 hour coverage, so as to ensure that activity underway and related decision-making processes at EOC are effectively communicated to the radio and T.V. network spokespersons. The decisions that involve line shut downs, as well as service restorations (that do occur towards the latter phases of any storm especially as snow clearing efforts begin to yield tangible benefits), should be communicated in as timely a manner as possible.

B. WMATA SUPERVISION

Normal WMATA operations as well as emergency conditions that result from natural or unforseen situations are directed by the bus and rail Operations Control Centers (OCC's) located in the lower level of the Jackson Graham Building, 600 Fifth Street, NW, in the District of Columbia. Into the OCC's flows information by telephone, radio and from the rail signal network. The bus and rail operations have separate, side-by-side, control rooms.

According to the Management Memorandum #127, weather monitoring is the responsibility of the Bus OCC. In the event of anticipated severe weather the Bus OCC notifies, among others, the General Manager. The General Manager then determines if a weather emergency exists. If this is determined, the Deputy General Manager than establishes the Emergency Operations Center (EOC) and the Support Operations Center (SOC). The EOC is located in the General Manager's Conference Room on the second floor of the Jackson Graham Building. This plan was in effect from January 22 to the 29.

As early as January 20, the weather service* was predicting three to six inches of snow. The Accu-Weather's forecast was updated on January 21 with the storm predicted to begin between 5:00 a.m. – 7:00 a.m. on January 22 with 10 inches of snow expected. At 4:00 p.m. on January 21, Bus OCC issued a system–wide level I alert. Early in the morning of January 22, WMATA placed personnel to deal with the expected snow.

The SOC was combined with the EOC in the General Manager's Conference Room. Telephone communication was maintained with the two OCC's. The EOC operated under the direction of the Deputy General Manager from early in the morning of January 22 thru Friday January 23. From that time on the EOC was under the direction of the General Manager. The EOC had major meetings throughout the January 22-28 period. The EOC was suspended on January 29 following a report to the WMATA Board.

It should be noted that WMATA had conducted internal evaluations of each departments' readiness for winter operations as part of the routine winter preparations. Prior to January 22 each WMATA Department reported to the General Manager that they were ready for the two to four inches of snow that initially was expected for January 22nd.

*Accu-Weather, Inc. report to Facilities Maintenance

C. FEDERAL GOVERNMENT ACTIONS

The Federal Office of Personnel Management (OPM) advised the EOC at 10:00 a.m. on January 22 that it was releasing Washington area federal employees beginning at 10:30 a.m. This was the latest time that WMATA could retain train and bus operators coming off of morning rush hour duty. This early release resulted in a "continuing" rush hour that eliminated any opportunity for effective road snow plowing by area agencies. Metrobuses used to carry passengers from metrorail stations were caught and often immobilized in heavy traffic marked by blocked lanes and stalled autos.

D. EOC/SOC

WMATA's EOC should be and is the principle contact sub-group for coordination with key outside agencies during such storm emergencies. Matters related directly to the actual operations of the Rail and Bus Lines during the storm would appear to be best supported or handled by SOC with oversight by EOC. The SOC staff must be intimately familiar with their respective department's operations, so as to effectively respond to developing situations and to direct timely deployment of support manpower and materials. WMATA management memorandum No. 127 does not define alternate persons to fill such key roles in the absence of those designated with the such responsibilities. This lack of a defined "alternates" list for EOC and SOC could severely impair WMATA's initiatives and momentum in dealing with such storms in the future. The need for a well staffed SOC at such times is critical. It is SOC which monitors timely information regarding fleet availability, manpower needs and the necessity to protect the rail fleet and the measures that would be implemented to do so, as well as the need to prioritize resources to ensure service stability. During a major storm or between storms such as occurred in January, it is imperative for middle to senior level managers to be billeted at an SOC. The purpose being to coordinate the needs of their respective departments with the emerging needs of field personnel who are dealing with abnormal field conditions. The initial plans and decisions to clear rail yards as well as keep open specific lines could be and should be initiated at the SOC, as those senior managers would be in best position to know of conditions based on information flow. Similarly, the SOC would maintain the closest contact with the EOC, apprising the most senior managers at EOC fully of the initiatives that are underway, as well as information that relates to car availability, car locations, manpower needs or shortages, and other storm or actions-taken related information. An EOC, so informed, can modify such initiatives or approve actions taken and in turn can inform the various public information agencies about such efforts. Where such a carefully coordinated effort does not exist between SOC and EOC, an individual department's goals will frequently "bog" an operation down, especially during the critical recovery phase in a storm situation.

E. PASSENGER AND MEDIA ANNOUNCEMENTS

Passenger and media announcements during the early days of the storm did not accurately reflect the actual service conditions. As a result of incorrect media announcements about rail line operations, passengers went to stations but found trains overcrowded to the point of not being able to take on more passengers. The long intervals between trains and the uncertainty of when trains would arrive caused much disappointment and distress. It appears that the Public Affairs office was provided with late and inaccurate information due to the constantly changing situation. This was compounded by the WMATA Office of Public Affairs being at the end of a long and complex information system. Their principal source of information were reports from the bus and rail departments-those departments had, as their first priority, the providing of service. Their attention and energies were directed to that goal with only secondary consideration of providing public information.

Many commuters in the Washington area depend on Metro and are guided in their travel decisions by media reports. Therefore, those reports (provided by WMATA Office of Public Affairs), must be as accurate and timely as possible. It should be noted that several other transit systems routinely have staff public relations personnel in their OCC's. These persons are experi-cnced in transit operations and can interpret the situation and translate the information into an accurate media or passenger message. This method frees the operating personnel to perform their primary functions and still provides direct and timely information to the media and passengers.

F. METRORAIL OPERATIONS

The focus of attention during the severe weather period was on Metrorail. Passengers traditionally expect rail transit to continue service when bus operations falter due to snow and ice. Thus many passengers expected rail service to be in full operation during the storms. The problems encountered were many.

Winter operations of a rail transit system can encounter a wide variety of weather conditions-precipitation (snow or freezing rain), low temperatures (cold), and wind. Depending on their severity all can singularly affect the operations. In combination of two or all three they can cause serious operational difficulties even though the severity of each is not great.

A winterization program for a rail transit system therefore must recognize and address all three weather conditions and their possible effects on both main line and yard operations.

The weather experienced in Washington, DC from January 22-27, included all three of the above conditions in varying combinations during this period.

Metrorail operations in the afternoon of January 22 were on the basis of continuing to provide service as long as possible and not to interrupt service to send out plows and third rail ice clearing vehicles. When trains eventually stalled, particularly on the Red Line at Grosvenor and Shady Grove and on the Orange Line at East Falls Church and Vienna, recovery operations were slow in getting underway and resulted in long delays in removing passengers from the stalled trains.

The light dry snow and high winds resulted in continued drifting even after plowing was completed. WMATA has two snow blowers that are used when mounted on hy-rail trucks. These consist of auger blades and blowers that can direct the blown snow in several directions. They were neither mounted nor used during the storm period.

The present design of the third rail coverboard permits snow to accumulate next to the third rail. This snow is compacted by the collector shoes on the cars and eventually lifts the shoes off the third rail. This causes arcing which produces heat which melts the snow into water. The water distributes itself on the third rail and freezes. This process continues resulting in very poor or no contact between the shoe and the third rail. When this happens the rail cars eventually stall.

There were several instances where the effective deployment and use of the plowing and third rail ice clearing equipment could be questioned. If the mainlines were open and cars were in service, then the plowing equipment could be used to clear yard tracks. When the mainlines were impassable, then the equipment should be used to restore service. The clearing of yards to permit the make-up of trains and to move cars to the repair areas of the shops must have priority if operations are to be sustained. It is recognized that keeping the mainline open is the top priority, however some attention must be directed to the yards and shop tracks.

WMATA has several sets of snow plowing locomotives coupled to special ice clearing flat cars. The flat cars are arranged to scrape ice from the third rail and to spray a glycol mixture on the third rail. The WMATA designed equipment was not extensively tested, thus its actual capabilities were not proven. To operate in between revenue trains it must sustain a speed of about 25 mph. During actual plowing the effective plowing speed was found to be in the range of 5-10 mph.

It quickly was evident that plowing operations at higher speeds resulted in broken scraper blades. The effectiveness of the equipment under various snow/ice conditions should be evaluated. Consideration should be given to a suitable test program.

The effectiveness of various glycol mixes at various temperatures should be determined beforehand. Constant monitoring of the effectiveness of the ice clearing vehicle should be done so that their use results in maximum snow/ice clearing. Rail supervisors should be added to the crews to provide instant communications and response when the vehicles are in use, particularly in recovery operations and when mixed in between revenue trains.

Compounding the plowing and third rail clearing vehicle problems was the factor of the WMATA third rail coverboard design. Third rail coverboards primarily are used to reduce potential contact with the third rail by employees and others who may be in the trackway. The WMATA coverboard covers the top and the one side (away from the running rails) down to the bottom of the third rail. The heavy snows of January 22 and 24/25 were sufficient to cover the entire coverboard. When trains or the ice clearing vehicles were run over the tracks, the current

collector shoes or ice scrapers forced the snow into the space between the coverboard and the third rail. This packed snow causes resistance which breaks the shoes/ice scrapers. Note that, if the shoes or scrapers were "stronger" then derailment or displacement of the third rail could result. Attention should be directed to modifying the coverboard design to allow "plowed" snow to escape. Such a coverboard design also could preclude the snow packing since a more open design might allow wind to provide a self cleaning effect.

Other opportunities exist with a different or modified coverboard for keeping the third rail clear of snow. Brushes might be used on railcars or the ice clearing trains that could permit higher speeds. Development of this concept would require further study.

Another method of ensuring good third rail contact involves the use of heaters. These devices are expensive but also quite effective. Their use should be carefully considered for critical areas such as acceleration points, inclines, crossovers and critical yard tracks and loops, and before and after signals where a train is likely to be stopped during normal operations. If snow is permitted to accumulate in the area of the moveable portions of a track switch it will obstruct the movement and prevent closing of the switch points. In order to prevent this the switch should be heated. On main line and yard applications the heating cable can be fastened to the side of the rail. Other types of heating can be used to supplement the rail heating. This is especially important at main line crossovers at terminals.

Whenever heating is used to control snow and/or ice, water will be produced. If this water is not controlled it will flow from the heated area and freeze. This will continue until the ice prevents the water from flowing away. The water will stay where it is produced, build up, and eventually freeze causing icing problems. It therefore is necessary to design into any heating system a facility to permit the water to drain away. These facilities also must be heated as do the drains which they feed.

For areas of new construction snow fencing can be used to prevent snow from drifting onto trackways. This practice has now been refined and it is now possible to control snow with strategically placed snow fencing as well as with planting of trees and shrubs. Structures are now being attached to buildings that control wind patterns and thereby control the snow deposits.

These techniques have been successfully employed and have overcome some very serious snow drifting problems. The control of drifting snow on the main line, in yards and around buildings including garages, carhouses and offices can be achieved. The control of drifting or wind borne snow can be determined using a model of the area of concern. The snow patterns can be established and control measures tested before costly installations are undertaken in the field.

G. RAILCAR AVAILABILITY

From the data presented there appeared to be substantial discrepancies regarding fleet availability for the period following the first storm. This situation was aggravated by the second storm.

One of the major reasons indicated was the inability to move trains out of the yards. However, on January 23, 334 of the 466 cars reported as available by Maintenance entered revenue service for the morning rush hour. This number was substantially reduced by the PM rush hour. The data supplied depicts a steady decline in car availability and an increase in cars out of service for repair. Several conditions may have contributed to this situation.

1. There were a substantial number of cars reported to be in serviceable condition that in actuality required repair, since the number of "O.K." cars reported by Maintenance was based on the assumption that if a car had not been reported for trouble it was available for service. The actual status of the fleet could not be confirmed, and when the cars were released for service the malfunctions were discovered.

2. The cars that were operated in revenue service experienced a substantial amount of failures that maintenance was unable to keep up with due to yard conditions and limited access to shops.

3. It was difficult to confirm exact status of cars until January 28th.

It is possible that a combination of all of the above existed. In reviewing the numbers of "cars unavailable due to repair action" the fall-out rate suggests that many were reported as serviceable, but stuck in the yard. When they were finally moved the equipment failures were discovered. The cumulative fallout rate from January 22-28 averaged 40 cars per day except on January 23, when the rate increased to 104 cars. Assuming that Maintenance was repairing cars during this period the fallout rate had to exceed an average of 100-120 cars per day.

H. CAR EQUIPMENT PERFORMANCE

Based on car defect information provided there are several subsystems failure categories that are relative to the inclement weather conditions. However, it is not possible to distinguish between problems related to snow or problems related to low temperatures.

The subsystems impacted severely by inclement weather conditions are as follows:

1. Auxiliary Power
2. Doors
3. Primary Power
4. Propulsion

AUXILIARY POWER

The auxiliary power fuse is designed to protect solid state equipment, yet in its application on the WMATA car it protects mainly electric motor circuits. The constant cycling of power to these subsystems that would be caused by icy third rail is not compatible with the I^2t rating of the fuse.

In addition, many of the subsystem 750 volt control devices, such as the motor generator resistor panel, get packed with snow during operation in snow storms. This leads to low resistance grounds resulting in blown auxiliary fuses.

Although these individual circuits are protected by circuit breakers their time constant is not compatible with the time constant of the fuse.

DOORS

Doors need additional attention during snow conditions due to salt, sodium chloride, sand, etc. being used on station platforms and are tracked onto door tracks. Additional cleaning forces need to be provided during such conditions.

PRIMARY POWER

Several car failures were caused by current collector shoes breaking due to packed snow and ice under the coverboard. In addition, current flow interruptions caused main shoe fuses to open.

PROPULSION

The propulsion subsystem is normally the most susceptible part of the vehicle to be influenced by severe weather conditions. In this particular case the conditions were further aggravated by the intermittent electrical contact between the car and the third rail due to the reported ice built up. The propulsion system failures were broken down into 228 electronic control components and flashovers, and 106 traction motors. It is not clear if the traction motor failures occurred independent of the control failures or if they were secondary failures as a result of control failures.

It was interesting to note that the majority of the 228 electronic control component and flashover failures were related to the chopper equipped cars. This is surprising since the pneumatic cam controller is susceptible to failures during cold weather operation.

The chopper failures described are as follows:

1. Snow entering the chopper high power electronic box through the forced cooling system, causing flashovers.

2. Failures of the filter capacitors on the power input circuit of the chopper: It would appear that the input circuit is not designed to withstand constant cycling caused by third rail icing. The infiltration of snow into the high power electronic box appears to be associated with the

location of the air intake of the cooling system. The WMATA chopper air intake is located under the car. The air is forced by fan through a filter, located on the outside of the air duct, over the power electronic devises for cooling. The failures experienced reportedly were caused by snow infiltration.

The majority of traction failures for self ventilated motors during inclement weather conditions occur as a result of control failures, deterioration of insulation resistance, and dirt. Deterioration of the insulation resistance results in grounded motors, and excessive dirt in the motor results in flashovers and/or grounded motors.

I. DAILY SAFETY TEST (DST)

The inability to perform this test in locations other than the yards that are equipped with test loops for the 298 Rohr built transit cars was given as a major reason for not storing cars in the tunnel during severe weather conditions.

The daily safety test cycles the automatic train control system of the car to verify that the speed codes utilized by the Automatic Train Protection (ATP) Systems are responding to the wayside signals. Absence of the wayside code, or failure of the carborne equipment to recognize/ acknowledge this code results in a brake application command. The test itself does not verify a brake application, it merely verifies that the ATP system responds to the code.

The test could be compared to the departure test on mainline railroads that are equipped with cab signals. Unlike the departure test, it varies in that it is performed only once every 24 hours rather than every time an operating cab is established, or reversal of train movement. Presently WMATA is testing every cab on a 24 hour basis even though only the lead cab of a train is active. This is done to permit the cutting of trains (reducing the number of cars in a train) without the need for retesting.

The new Breda car fleet also is tested in the same manner; however, the cars have their own test loops (coils) built in and talk to themselves without the need of a fixed wayside test loop. They can, therefore, be tested anywhere.

In reviewing the out of service listing for transit cars there was no listing for cars out of service due to the inability to perform the DST. However, this may not have been considered as requiring repair action, and was therefore not listed.

IV. CONCLUSIONS

FINDINGS

1. The weather of January 22-27 was severe. Nine and 11-inch snowfalls were connected by below freezing temperatures producing what was, in effect, a 20" snowfall. Snowfalls of this magnitude are unusual in the Washington area. In the last 10 years snowfalls of 20" or more have occurred only in 1979 and in 1983.

2. WMATA has detailed plans for severe weather operations. The plans, however, are primarily departmental in focus even though the underlying theme in *all* the departmental snow plans is "moving passengers safely and expeditiously."

3. Announcements made to the media and to passengers did not reflect actual conditions or service levels that were being experienced.

4. WMATA snow ice clearing equipment was insufficient and could not be effectively employed at critical times.

5. The current third rail coverboard design serves to trap snow, and this results in ice formations which interferes with train operations.

6. WMATA's newly developed third rail ice clearing vehicles had experienced only limited testing prior to the storm.

7. The rail cars had failures of critical subsystems due to cold and snow.

8. The exact status and location of available cars could not always be accurately determined.

9. The responsibility for snow removal in yards is separate from the car maintenance function.

10. The electrical characteristics of the auxiliary fuse are not compatible with branch circuit breakers.

11. Exposed portions of car electrical equipment were short circuited by snow.

12. Chopper propulsion equipped cars had failures due to cooling system problems.

13. The need for the Daily Safety Check restricted the storage of railcars in tunnels.

V. RECOMMENDATIONS

The following recommendations cover areas that the Committee, based on its review, feels should be improved. Should the recommendations be accepted by WMATA, it would be WMATA's responsibility to take specific steps for their implementation. WMATA may develop alternate solutions that produce equal or better results than those recommended by the Committee.

A. MANAGEMENT AND PLANNING

1. Prepare an integrated severe weather plan providing for centralized decision making authority. The four segments of the snow plan should be put under one cover and a careful reassessment and integration of each segment accomplished, especially in light of the lessons learned from the recent snow storms. An external goal would be the development of a regional snow plan that would use one weather forecasting service as the basis for decisions.

2. An appropriate chain-of-command should be established for implementation of the snow plan. Persons immediately below the Deputy General Manager should be identified with regards to their authority for implementation of the snow plan.

3. All persons who have responsibilities for elements within the snow plan should be issued copies of the completed and integrated document, so that they could better understand their respective roles and functions as it relates to other departments.

4. A permanent location for the SOC should be established as soon as possible. The SOC should be readily accessible to the operation control centers (OCC) and should include key elements from the support groups such as Facilities Maintenance, Rail and Bus Maintenance, and Public Affairs. The SOC should have provision for an adequate number of phones as well as radios to enable personnel to stay on top of field conditions as they unfold as well as to communicate operating decisions to the EOC both as updates and for approval.

5. A careful rethinking of the integrated snow plan should be given to carefully detail, where possible, those interactions among the various departments that are essential during such snow storm emergencies as well as the defining of the primary people and positions responsible for specific functions during such emergencies. An "alternates" list should be included for each of those functions so as to make it clear to any and all individuals within those departments, who is responsible for what even in the absence of the primary designee.

6. Improve the coordination between yard and shop operations to improve car location and status reporting and to improve the snow clearing operation.

7. Establish a centralized car location/status system that would provide up-to-date information by car number regarding the location and the status of the railcars.

8. WMATA should provide a training/simulation program which periodically tests and strengthens the ability of key personnel to react to emergency situations. Participants should be from all operating departments.

9. WMATA should have or acquire a sufficient number of prime movers (locomotives) to be deployed in strategic locations for recovery operations when there is a possibility of stalled trains.

10. The severe weather plan should provide for the underground storage and removal of cars which are required for weekday services.

B. CAR EQUIPMENT

1. Evaluate possible modifications to railcar subsystems to reduce effects of cold and snow.

2. Ensure that the auxiliary fuse is electrically compatible with branch circuit breakers.

3. Evaluate additional protection for exposed 750 volt equipment against packing snow.

4. Consider improving the chopper cooling air intake location to reduce snow ingestion. This may only be practical on future cars.

5. Design and build portable Daily Safety test equipment that will provide the ability to test the equipment in places other than the fixed loops in the yards. This could be accomplished by

using portable test loops that can be placed under the car for the test. Since the testing can be limited to the lead cars during emergencies this should provide the flexibility to test in the tunnel without adding a major burden to the maintenance crews. However, when trains are separated it would require testing of lead cars that had not previously been tested. This would not alter the basic concept, since the Breda cars are already tested in this fashion.

C. SNOW PLOWING AND CLEARING

1. Make maximum effective use of the snow plowing equipment.

2. The snow plan should detail cleaning operations, including yards, on a priority basis.

3. All locomotives and work equipment should be equipped with couplers or towbars that are compatible with revenue equipment to facilitate towing/recovery operations.

4. Snow ice clearing operations must be coordinated with train operations.

5. Continue testing and evaluating ice clearing vehicles to improve usage, effectiveness and compatibility with revenue trains.

6. Evaluate the third rail coverboard to reduce or eliminate the tendency to trap snow and consider installation of third rail heaters at critical locations.

7. Investigate snow control techniques for areas susceptible to drifting snow.

D. MEDIA AND PASSENGER ANNOUNCEMENTS

1. Improve the accuracy and timeliness of media and passenger announcements.

2. Assign Public Affairs personnel to the OCC to interpret emergency situations and translate the information into media and passenger messages.

3. Ensure media representatives are familiar with the OCC to learn first-hand the problems and possible solutions.

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